

## CHAPTER 19

### CHUTES

#### 19-1. General.

a. Description. A chute is a steep open channel which provides a method of discharging accumulated surface runoff over fills and embankments. A typical design is shown in figure 19-1 and design charts for chutes constructed of concrete for various gradients and discharges are shown in figure 19-2. Frost penetration beneath the structure will be restricted to nonfrost-susceptible materials using procedures outlined in table 8-4, since small increments of heave may seriously affect its drainage capacity and stability. The following features of the chute will be given special consideration in the preparation of the design.

b. Configuration. The berm at the edge of the fill will have sufficient freeboard to prevent overtopping from discharges in excess of design runoff. A minimum height of wall of one and one-half times the computed depth of flow is suggested. This depth is also normally adequate to contain any swelling effect that may be present due to air entrainment. Turfed berm slopes will not be steeper than one vertical to three horizontal because they cannot be properly mowed with gang mowers.

c. Construction. A paved approach apron is desirable to eliminate erosion at the entrance to the chute. A cutoff wall should be provided around the upstream edge of the apron to prevent undercutting, and consideration should be given to effects of frost action in the design. Experience has shown that a level apron minimizes erosion of adjacent soil and is self-cleaning as a result of increased velocities approaching the critical section.

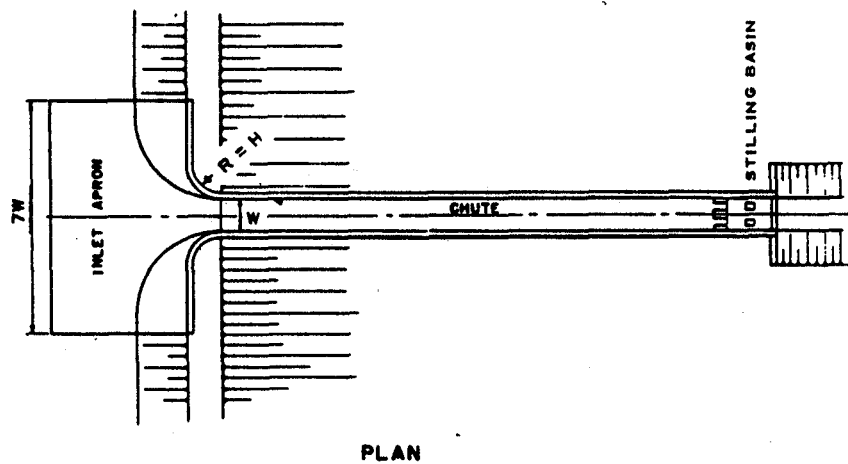
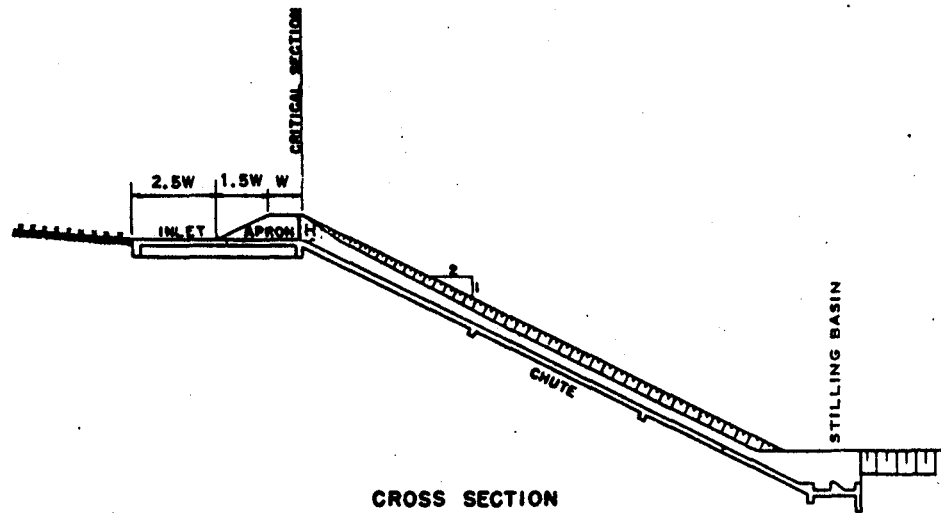
d. The following equation will provide a satisfactory determination of the discharge for the chute shown in figure 19-1.

$$Q = 3.75 W^{0.90} H^{1.6}$$

where:

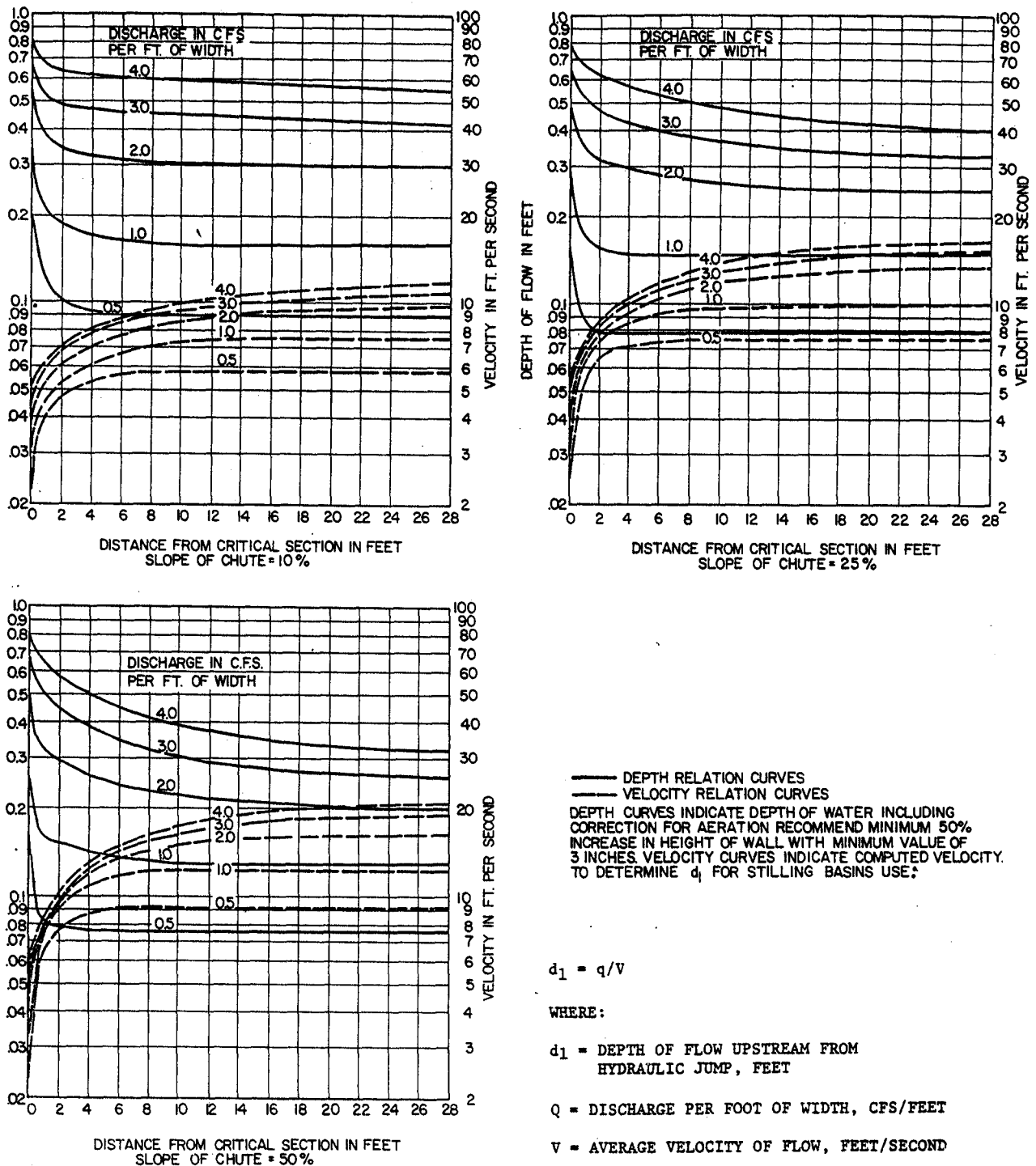
Q = Discharge, cfs  
W = Width of flume, feet  
H = Head, feet

Adequate freeboard is most important in the design of a concrete chute. The critical section where most failures have been experienced is at the entrance where the structure passes through the berm. As indicated earlier, a minimum freeboard equal to one and one-half times the



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FIGURE 19-1. DETAILS OF TYPICAL DRAINAGE CHUTE



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FIGURE 19-2. DESIGN CHARTS FOR CONCRETE DRAINAGE CHUTE

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computed depth of flow is recommended. A minimum depth of 3 inches is suggested for the chute. Minor irregularities in the finish of the chute frequently result in major flow disturbances and may even cause over topping of sidewalls and structural failure. Consequently, special care must be given to securing a uniform concrete finish and adequate structural design to minimize cracking, settlement, heaving, or creeping. A suitable means for energy dissipation or erosion prevention will be provided at the end of the chute.

19-2. Design problem. Design a concrete chute for a discharge of 8 fps, if the chute is to have a 25 percent slope and is to be 30 feet long.

19-3. Solution. Assume width of chute to be 2 feet. Then discharge  $Q = 3.75W^{0.9} H^{1.6}$  or

$$H = (Q/3.75W^{0.9})^{1.6} = (8.0/3.75 \times 2.0^{0.9})^{1.6} = 1.09 \text{ feet}$$

Provide berm at least 1.5 feet high.

From figure 19-2, the depth of flow at various stations along the chute can be determined from the depth-relation curve for  $q = 4.0$  cfs per foot as follows:

Station feet	Depth of flow $d_1$ feet	Minimum height of sidewall ( $1.5 \times d_1$ ) feet	Adopted height of sidewall inches
0+00	0.80	1.20	18
0+02	0.63	0.95	12
0+05	0.56	0.84	10
0+10	0.49	0.74	9
0+20	0.42	0.63	8
0+30	0.40	0.60	8